Before the
Federal Communications Commission
Washington, D.C. 20554

In the Matter of	)	
Update to Parts 2 and 25 Concerning Non-Geostationary, Fixed-Satellite Service Systems and Related Matters	)	IB Docket No. 16-408

COMMENTS TO THE NOTICE OF PROPOSED RULEMAKING

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COMMENTS OF SPACE NORWAY AS

1. INTRODUCTION

Space Norway AS ("Space Norway") respectfully submits these comments in response to the Notice of Proposed Rulemaking ("NPRM")[1] concerning certain Federal Communication Commission (the "Commission") rules and policies governing satellite services. The Commission has proposed to update, clarify, and streamline its rules to facilitate the deployment of non-geostationary satellite orbit ("NGSO"), fixed-satellite services ("FSS") systems and update specific rules governing operation of FSS space stations in the geostationary-satellite orbit ("GSO") to facilitate operational flexibility.[2]

2. DISCUSSION

a. Ka-band Plan

A. 17.8-18.3 GHz. The Commission proposes to: (i) adopt a new secondary allocation to the FSS (space-to-Earth) in the 17.8-18.3 GHz band subject to protection of the

[1] *Update to Parts 2 and 25 Concerning Non-Geostationary, Fixed-Satellite Service Systems and Related Matters*, Notice of Proposed Rulemaking, IB Docket No. 16-408 (proposed Dec. 15, 2016).
[2] *Id.* ¶ 1.

primary fixed service ("FS"), (ii) include in the Commission's Rules the international power flux-density ("PFD") limits on space stations in the 17.8-18.3 GHz band and (iii) authorize NGSO FSS systems in the 17.8-18.3 GHz band on an unprotected, non-interference ("UNI") basis with respect to GSO FSS networks.[3]

Space Norway supports the inclusion of the new secondary allocation to the FSS (space-to-Earth) in the 17.8-18.3 GHz band. Because the new allocation is secondary and the only other service in the 17.8-18.3 GHz band is the FS, Space Norway proposes that the Commission not limit FSS use in the 17.8-18.3 GHz band to communications with individually licensed stations (as is required by proposed footnote NGXX2 in the NPRM) but instead allow the ubiquitous deployment of NGSO FSS user terminals for a special subset of NGSO systems, those using space stations in highly elliptical orbits ("HEO"). This special subset of HEO systems, to which ITU-R Resolution 147 applies, is known as highly inclined orbits ("HIO").

ITU-R Resolution 147 clearly states that both studies and practical experience demonstrate that HIO systems do not cause harmful interference towards FS as long as they operate in accordance with the PFD limits established in ITU-R Resolution 147 (*see also* RR No. 21.16.6B) for the 17.7-19.7 GHz band.[4] Thus, because: (i) such PFD limits will protect terrestrial services from harmful interference from HIO systems, and (ii) all NGSO FSS user terminals will operate on a UNI basis, terrestrial operators will not be materially burdened by allowing ubiquitous deployment of NGSO FSS user terminals for HIO systems operating in the 17.8-18.3 GHz band. In addition, GSO FSS user terminals will be protected through the application of International Telecommunication Union ("ITU") Radio Regulations ("RR")

[3] *Id.* ¶ 9.
[4] *See* RR No. 21.16.6B.

Article 22 EPFD Limits that the Commission also proposes to include in the Commission's rules in the NPRM.

Lastly, international PFD limits were developed by the ITU with the cooperation and input of the global FSS and FS industry, and are universally accepted as sufficient protection for FS from FSS. As noted by the Commission, the United States, with input from U.S. terrestrial operators, participated actively in the development of ITU PFD limits.[5] Space Norway believes that these limits should be included in the Commission's Rules, and it encourages all steps towards harmonization of the Commission's Rules with the RR.

B. *18.3-18.6 GHz and 19.7-20.2 GHz*. The Commission proposes to allow NGSO FSS systems to operate downlinks on a UNI basis with regard to GSO FSS networks in the 18.3-18.6 GHz and 19.7-20.2 GHz bands, subject to compliance with limits on equivalent power flux-density ("EPFD") to protect GSO FSS networks.[6] Space Norway supports this proposal and agrees that the international EPFD limits will provide sufficient protection for GSO systems.

C. *18.8-19.3 GHz*. Furthermore, the Commission proposes to authorize GSO FSS (space-to-Earth) operations in the 18.8-19.3 GHz band on a UNI basis in relation to NGSO FSS systems, consistent with previous waivers granted by the International Bureau and matching the current secondary GSO FSS designation in the paired 28.6-29.1 GHz uplink band.[7] Space Norway supports the codification of a practice that has been established through waivers. A secondary user will often increase the burden on the primary user. However, as coordination is required among satellite operators, this new secondary allocation will not substantially increase the burden on the primary user.

[5] *Id.*
[6] *Id.* ¶ 10.
[7] *Id.* ¶ 11.

D. *18.8-19.3 GHz and 28.6-29.1 GHz*. The Commission additionally proposes providing GSO operations co-primary status with NGSO operations in the 18.8-19.3 GHz and 28.6-29.1 GHz bands[8], a proposal that Space Norway does not consider prudent. In the majority of FSS allocations, NGSO systems are required to operate on a secondary basis with regard to GSO systems. As such, because the frequency bands in which NGSO systems have primary status is limited, Space Norway strongly believes that the primary status of NGSO systems should be maintained in those bands in which this status already exists to provide NGSO operators maximum flexibility in choosing their system characteristics, particularly with respect to geographical areas of operation and deployment of small, ubiquitous user terminals. The bands to which EPFD limits and RR Article 22 do not apply (including the 18.8-19.3 GHz and 28.6-29.1 GHz bands) give NGSO FSS operators more leeway in designing their systems, and in developing innovative service offerings, than in other bands. This makes the bands where the limits do not apply very important for NGSO FSS operators. Space Norway does not have any issues with secondary allocations with regard to GSO FSS in the 18.8-19.3 GHz and 28.6-29.1 GHz bands.

E. *19.3-19.4 GHz, 19.6-19.7 GHz, and 29.3-29.5 GHz*. Moreover, the Commission proposes to allow GSO and NGSO FSS systems to operate in the 19.3-19.4 GHz, 19.6-19.7 GHz, and 29.3-29.5 GHz bands currently designated for NGSO MSS feeder links and to authorize NGSO systems on a UNI basis with respect to GSO FSS systems in such bands.[9] Space Norway supports the inclusion of these new FSS allocations, but believes that GSO systems should not have priority over NGSO systems. Equal status among NGSO and GSO systems is more appropriate. In regard to coordination with FS, Space Norway believes that this can be

[8] *Id.* ¶ 12.
[9] *Id.* ¶ 13.

accomplished with known technical parameters for both FS and FSS systems and by following the "first come, first served" principle. The new proposed footnote NGXX2 should not exclude blanket licenses for NGSO FSS (space-to-Earth) user terminals operating in HIO systems, to which ITU-R Resolution 147 applies. As noted above, terrestrial services are sufficiently protected through application of the ITU's PFD limits.

F. *Codification*. Similarly, the Commission proposes to: (i) codify the Ka-band Plan's satellite designations into footnotes to the U.S. Table of Frequency Allocations (the "Table"), remove certain repetitive notes in section 25.202(a)(1), (ii) incorporate into footnotes in the Table those frequency-use restrictions that were not amended in the Commission's Spectrum Frontiers proceeding, and (iii) specify the limitation on NGSO FSS deployment in the 10.7-11.7 GHz and 12.75-13.25 GHz bands as to individually licensed stations only.[10] The Commission intends only to note the restrictions on FSS not codified in the Table.[11]

Space Norway supports the proposed codification of the Ka-band Plan's satellite designations into the Table; this will provide clarity and improve the readability of the Commission's Rules. Space Norway also agrees with the proposed modification regarding NGSO FSS operations in the 10.7-11.7 GHz band, but believes that ubiquitous deployment or blanket licenses should be allowed on a UNI basis for those NGSO systems to which RR No. 21.16.17 applies.

G. *PFD Limits in 17.7-19.7 GHz for GSO FSS Space Stations*. The Commission proposes to make the limits in section 25.208(c) of the Table applicable to GSO FSS space

[10] *Id.* ¶ 14.
[11] *Id.*

stations in the 17.7-19.7 GHz frequency band and to all space stations in the 22.55-23.55 GHz and 24.45-24.75 GHz frequency bands.[12] Space Norway supports all of these extensions.

H. *PFD Limits for NGSO FSS Space Stations*. The Commission further proposes to extend the applicability of the PFD limits in section 25.208(e) to NGSO FSS space stations in the 17.8-18.6 GHz and 18.8-19.7 GHz frequency bands.[13] Until an appropriate EPFD limit for the protection of terrestrial stations in the 17.8-18.6 and 18.8-19.7 GHz bands is established, the Commission also proposes that an NGSO FSS constellation be considered as having met the requirements established in section 25.208(e) of the Table if the aggregate PFD produced by the whole constellation at any point in the Earth's surface does not exceed -115 (dBW/m^2)/MHz.[14]

Space Norway supports both extending the applicability of the PFD limits in section 25.208(e) and the development of appropriate EPFD limits for NGSO systems except where ITU-R Resolution 147 applies. In cases where ITU-R Resolution 147 applies, Space Norway believes that the PFD limit currently included in section 25.208(e) should apply. HIO systems, as described in ITU-R Resolution 147, have a very limited number of satellites that are simultaneously active. As a result, Space Norway is of the opinion that compliance with EPFD limits is not necessary for HIO systems to protect terrestrial stations in the 17.8-18.6 and 18.8-19.7 GHz bands because compliance with the PDF limit in section 25.208(e) is sufficient for this purpose.

I. *Other Comments*. Finally, the Commission requests comment on any other relevant matters that should be considered regarding the use of NGSO FSS systems.[15] Space Norway believes that ubiquitous FSS (space-to-Earth) user terminals for both GSO and NGSO

[12] *Id.* ¶ 15.
[13] *Id.* ¶ 16.
[14] *Id.*
[15] *Id.* ¶ 17.

systems operating on a UNI basis should be allowed in all bands allocated to that service. If the location of transmitting terrestrial stations and the frequency at which they operate is known, FSS user terminals should be able to find unused spectrum at such location. Using this method to find downlink spectrum will not put any constraints on terrestrial users since they will be protected through downlink PFD limits or possible future EPFD limits. Spectrum-sensing techniques and directional antennas employing different satellite orbits/positions that minimize the interference impact from terrestrial services, could be used if the location and/or frequency of the terrestrial stations cannot be disclosed. In some circumstances, there may be interference from terrestrial services, and FSS users would need to be made aware that loss of service may occur.

Space Norway strongly advocates for the Commission to give special consideration to NGSO systems operating in a HEO orbit, especially those with high inclination and operating with only one active satellite. Such systems are easily compatible with GSO systems and usually provide improved "quasi-GSO" coverage at northern latitudes. For example, a NGSO system in a HEO orbit with a 63-degree inclination and an apogee of 43,500 km will offer better elevation angles than GSO systems for more than 50% of the time around 55° North.

Space Norway also encourages the Commission to further align its Rules with the RR. In this regard, Space Norway proposes that footnote NG164 in the Table be aligned with RR No. 5.522B and that it read as follows: "The use of the 18.6-18.8 GHz band by the fixed-satellite service (space-to-Earth) is limited to geostationary-satellite networks systems and NGSO systems with an orbit of apogee greater than 20,000 km."

b. EPFD Limits

A. *Ka-band*. The Commission proposes to: (i) require NGSO FSS applicants in the 17.8-18.6 GHz, 19.7-20.2 GHz, 27.5-28.35 GHz, and 29.5-30 GHz bands to demonstrate compliance with applicable EPFD limits in a similar manner as NGSO FSS applicants are required to do for operations in the 10.7-14.5 GHz band, (ii) incorporate EPFD limits on inter-satellite emissions from NGSO FSS space stations into GSO FSS space stations and (iii) extend relevant RR Article 22 EPFD limits to the 19.3-19.4 GHz, 19.6-19.7 GHz and 29.3-29.5 GHz bands in which the Commission is proposing to allow new NGSO FSS operations on a UNI basis with respect to GSO FSS networks.[16]

Space Norway supports the inclusion of RR Article 22 EPFD limits and a requirement for applicants to demonstrate compliance with EPFD limits for operations in the Ka-band frequencies. Also, Space Norway supports extending the EPFD limits to cover the new NGSO FSS allocations, under the assumption that EPFD limits in RR Article 22 Table 22-1C will be used for the 19 GHz range and the limits in the two last rows in RR Article 22 Table 22-2 will be used for the 29 GHz range.

B. *Consolidation*. The Commission proposes to consolidate its NGSO FSS licensing provisions for operations in the Ka-band into the licensing rules for NGSO FSS operations in the 10.7-14.5 GHz band and requests comment on the ways in which the Commission might simplify section 25.146.[17] Space Norway supports the merger of the licensing provisions for NGSO FSS in the Ka- and Ku-bands. In regard to the simplification of section 25.146, Space Norway proposes that section 25.146 be updated to account for the readily available EPFD validation tool from the ITU.

[16] *Id.* ¶ 19.
[17] *Id.* ¶ 20.

C. *NGSO-GSO Default Sharing*. Finally, the Commission proposes the deletion of the first sentence of section 25.156(d)(5) and requests comment regarding the manner in which it should adopt a provision similar to RR No. 22.2.[18] Space Norway supports the deletion of the first sentence in section 25.156(d) and the adoption of a default sharing rule similar to RR No. 22.2. Furthermore, the Commission should codify a rule establishing that a showing of compliance with the international EPFD limits will be regarded as fulfilling sharing requirements.

c. Avoidance of In-Line Interference

A. *Section 25.261*. The Commission proposes adopting the avoidance of in-line interference mechanism codified in section 25.261 for all bands authorized for NGSO FSS use.[19] The Commission also proposes to clarify that section 25.261 applies solely to NGSO FSS systems communicating with earth stations with directional antennas, and it seeks comment regarding expanding this spectrum sharing method to NGSO FSS operations in other frequency bands.[20] Finally, the Commission intends to clarify that band-splitting procedures do not apply to applications granted on the condition of compliance with the avoidance of in-line interference mechanism specified in section 25.261, and it seeks comment on any other standard for assigning spectrum.[21]

As previously mentioned, Space Norway believes that the Commission should treat somewhat differently HEO NGSO systems, particularly the subset identified in the RR as HIO systems[22], which can be defined as "fixed-satellite service space stations using highly-inclined orbits having an apogee altitude greater than 18 000 km and an orbital inclination between 35°

[18] *Id.* ¶ 21.
[19] *Id.* ¶ 23.
[20] *Id.*
[21] *Id.*
[22] *See* RR No. 21.16.6B.

and 145°."[23] Such systems are in many ways more similar to GSO systems than NGSO systems. Because of their unique orbits, HEO systems dwell around their apogee for several hours and only one satellite is visible from their coverage area (except during handover), which is commonly a major portion of the Northern Hemisphere. The apogee height of HEO systems is also normally greater than the GSO orbit. HEO systems are likely the most cost-effective way to provide services to communities and vessels located at high latitudes where GSO services are not available or are limited in performance due to low elevation angles. In addition, the steady increase of sea and air traffic in these areas is imposing connectivity requirements on Search and Rescue services that are difficult to meet due to insufficient broadband access.

As a consequence of the distance between the Earth and the HEO satellite, particularly during apogee, the beams of a HEO satellite will have a relatively large footprint on the Earth even though the beam width is quite narrow in terms of its opening angle. This is important because it essentially means that multiple simultaneous in-line interference events can occur between one beam of a HEO system and a LEO or MEO system that has multiple satellites in multiple planes. These events will also happen continuously as "new" satellites enter the beam of the HEO system. If several constellations are deployed, in-line interference events will be even more frequent.

If no mechanism for avoidance of in-line interference between a HEO system and one or multiple large LEO/MEO systems exists, operations will be restricted to the chosen "home base" spectrum for the HEO system, and, given that band segmentation is in force, this will limit the amount of spectrum available for such LEO/MEO systems. Therefore, it will be of mutual

[23] *Id.* n.15.

interest to operators to reach coordination agreements that minimize the need to limit their spectrum usage.

A HEO system that has only one operational satellite (except during hand-over) cannot implement the commonly proposed techniques to avoid in-line interference such as satellite diversity, gateway diversity and progressive pitch.[24] More feasible sharing mechanisms include frequency or polarization band-segmentation. On the other hand, HEO systems take advantage of the long dwell time the satellite has around the apogee. As seen from Earth, a HEO system can provide services similar to a GSO network and operate through the same user terminals. A HIO satellite will be "quasi-stationary" as seen from a LEO/MEO satellite. RR Article 22 requires that LEO/MEO systems implement some sort of GSO arc avoidance system so that GSO networks are protected from NGSO systems. Moreover, LEO/MEO systems will most likely also have to implement some sort of in-line avoidance mechanism to be able to operate efficiently together with other systems. Ka-band systems must also protect, and thus have in-line avoidance techniques implemented with regard to, U.S. Federal HEO systems. Similar in-line avoidance techniques may be used by LEO/MEO systems towards all HEO systems.

To facilitate the efficient use of both HEO and LEO/MEO systems, Space Norway proposes that the responsibility for in-line interference avoidance between HEO and LEO/MEO systems be placed on the latter. LEO/MEO systems need to implement mechanisms for avoidance of in-line interference and GSO avoidance in any case, and it is in their interest not to restrict their operation to their chosen "home base" spectrum. Space Norway believes that this is the most efficient approach for both types of systems, as it will encourage operators to coordinate and put in place methods to prevent in-line interference events from occurring. The required separation angle between systems should be agreed upon through coordination using actual

[24] *See* ITU-R Recommendation S.1595.

system characteristics. Systems vary in design and on how much spectrum they need in order to fulfill service requirements. Not all systems require access to all allocated spectrum in order to operate satisfactorily. Therefore, those systems which require a large amount of spectrum should be expected to design a sophisticated system that allows them to mitigate interference to and from other systems.

Avoidance of in-line interference between HEO systems should be mandatory and obtained through coordination between operators. Normally, this could be obtained by carefully adjusting orbital parameters.

B. *Ephemeris Data*. The Commission further proposes to include the 18.8-19.3 GHz and 28.6-29.1 GHz bands in section 25.271(e) and apply this requirement explicitly to non-U.S.-licensed NGSO FSS operators that are granted market access in the United States. [25] Space Norway supports this addition. Good knowledge of orbital parameters is vital for the coordination and operation of multiple NGSO systems.

C. *10-degree Trigger*. The Commission invited comment in the NPRM as to whether the separation angle trigger should be increased or decreased to reflect current system designs.[26] Space Norway believes that if the principle of avoidance of in-line interference is adopted, any change to the trigger value should be based on studies performed on current and planned systems.

D. *Accommodation of Later Entrants*. Finally, the Commission requests comment on how best to balance the competing interests of encouraging access to the market while providing NGSO FSS operators assurances that they will have access to a minimum amount of spectrum

[25] *Id.* ¶ 24.
[26] *Id.* ¶ 26.

for their services.[27] Space Norway believes that the processing round approach should be applied, and that the spectrum available should be awarded only to qualified applicants in the processing round.

d. Earth Station e.i.r.p. Density Limits

A. *Earth Station e.i.r.p. Density Limits*. Space Norway believes that, with good knowledge about antenna diagrams and output powers, it should be easier to coordinate NGSO systems with one another. This applies to both uplink and downlink spectrum. Establishing a set of criteria that NGSO systems must meet would simplify the coordination process and likely result in a more efficient use of these systems.

Moreover, with respect to earth station equivalent isotropically radiated power ("e.i.r.p.") density limits, Space Norway believes that a certification from the satellite operator should suffice. Space Norway also supports the adaptation of GSO FSS e.i.r.p. density limits to NGSO FSS uplinks, and the adaption of GSO downlink power limitation and receive antenna gain requirements to NGSO FSS downlinks.

e. Milestones

A. *NGSO Milestone*. The Commission proposes to modify the six-year milestone obligation for NGSO systems to require the launch and operation of a percentage of the authorized constellation sufficient to provide substantial service to the public, concluding that 75 percent is a more appropriate number for this requirement.[28] Similarly, the Commission also seeks comment on any other modifications to its NGSO milestone policy, including whether or not the milestones should be applicable to large NGSO systems only.[29]

[27] *Id.* ¶ 27.
[28] *Id.* ¶ 32.
[29] *Id.*

Space Norway supports having a milestone requirement that is related to a percentage of operational satellites because defining service levels can be difficult and uncertain in some circumstances. Moreover, Space Norway agrees with the Commission's proposal to add a second milestone. However, because it takes time to develop a NGSO constellation, and full-scale deployment will most likely not occur before the system has been tested, Space Norway believes that the Commission's proposal for the first milestone may be too ambitious; a more appropriate number for this requirement is 10-20% of the satellites in the authorized constellation. With regard to the second milestone, Space Norway believes that if an operator fails to deploy the entire constellation after 9 years, then the license should be limited to the number of satellites launched at the milestone deadline. Moreover, should the Commission adopt criteria other than a percentage to measure compliance with these milestones, Space Norway believes that milestones should be based on quantitative and not qualitative criteria.

B. ***Replacements***. The Commission proposes to clarify in section 25.164 that both GSO and NGSO replacement space stations are not subject to the separate milestone requirements contained therein.[30] Space Norway supports this proposal.

f. Geographic Coverage

A. ***General***. In an effort to provide operators greater flexibility to design their systems to meet market standards, the Commission proposes to eliminate the directive requiring the design of NGSO FSS systems that operate in the 10.7-14.5 GHz, 18.8-19.3 GHz, or 28.6-29.1 GHz bands to enable service worldwide for at least 18 hours every day.[31] Space Norway supports the removal of this requirement because regional NGSO systems in highly inclined

[30] *Id.* ¶ 34.
[31] *Id.* ¶ 35.

orbits providing continuous coverage in high-latitude regions were effectively excluded from operating in the 10.7-14.5 GHz, 18.8-19.3 GHz and 28.6-29.1 GHz bands.

3. CONCLUSION

In conclusion, Space Norway respectfully requests that the Commission consider the above comments and adopt Space Norway's proposals relating to NGSO FSS systems.

Respectfully submitted,

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/s/

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